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ABSTRACT

A project was conducted to identify content for the development of a science skill inventory. This instrument is intended to measure teacher perceptions of the science skills needed by students for optimum success in secondary vocational programs. The resources of four college and university libraries, various curriculum and media centers, and commercially available secondary school science texts were used to conduct (1) a review of the current science literature, (2) a study to document the topical content of current secondary science textbooks, and (3) an analysis of research in science education. The science topics generated from these sources were entered into a computer, alphabetized, sorted, and evaluated for duplication, clarity, and reasonability in terms of the purposes of the project. As a result, a list of 334 science skills was selected for inclusion in the survey instrument, which is to be entitled the Science Skills/Knowledge Inventory. (This report includes the list of science topics generated during the literature analysis.) (MN)

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FINAL REPORT

IDENTIFICATION OF CONTENT FOR A SCIENCE SKILL INVENTORY TO BE USED FOR VOCATIONAL CURRICULUM STUDIES

(Contract Number 83-5004)

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Bureau of Vocational and Adult Education

Research Coordinating Unit
For Vocational Education

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ABSTRACT

Title: Identification of Content for a Science Skill Inventory to be used for Vocational Curriculum Studies

Submitted By: Huntingdon County Area Vocational-Technical School
Mill Creek, Pennsylvania

Funds Requested: $2,000

Beginning Date: 15 October 1984
Ending Date: 15 January 1985

Summary:

Objective. The objective of this project was to identify content for the development of an instrument--the Science Skill Inventory--which can measure teacher perceptions of the science skills needed for optimum success in selected secondary vocational programs, and the need for remediation of those skills in vocational students.

Procedures. The science content was developed from a survey of science topics (skills/knowledges) obtained from a review of science literature and standard secondary school science textbooks.

Contribution to Education. These project data will abet and promote the determination of science skills needed by secondary vocational students in a variety of specialties. Such information will have patent applicability to curriculum development, to meaningful curricular infusion of science concepts into vocational instruction, to research, and to remediation efforts in vocationally related instruction.

Product of the Project. This project identified the content for an instrument which can be used for science skill assessment in vocational education in the Commonwealth of Pennsylvania.

Background

A knowledge of science is important in everyday life as well as in most occupations. Most citizens use practical concepts from the disciplines of Biology, Chemistry and Physics in daily activities. As such, an understanding and application of science knowledge are essential for successful participation in this society.

In terms of occupations, science understandings are being required of workers today which were not considered important a decade ago. This issue, concerning an increased need for science awareness, is particularly important in vocational and technical specialties. This need reflects the incursion of higher forms of technology into the American workplace.

To address this issue, vocational educators and researchers need detailed identification of the science skills or understandings which are important to various vocational/technical specialties offered in selected Vocational Technical Programs of the Commonwealth.

Related Research

Concurrent with the need for promoting science understanding as reflected in (1) recent legislation, (2) literature concerning curriculum and in (3) the increasing emphasis on technology and high tech related occupations, one finds appalling evidence of decline in science knowledge in American youth.

Such evidence comes from many sources, but primarily from the studies done in the National Assessment of Educational Progress (NAEP). The following typify the findings over a decade.

"Science knowledge in American schools is declining." NAEP data show that 9, 13, and 17 year old students in 1973 could not answer science questions as well as their counterparts of 1969. Also cited were data which showed that large city youth demonstrated the greatest decline. Inner city youth were found to be well below the national average concerning science understanding and were not improving. Females scored below their male counterparts in all three age groups. The fall-off in scores was fairly national. Declines occurred in the Northeast, Central, and Western sections of the country. The Southeast showed no decline in score but remained below the national average. Rural youth, while below the national norm, showed an increase in science knowledge from 1969 to 1973 (National Assessment of Educational Progress, 1975).

In 1978, NAEP noted the general continuing decline in science knowledge for 17 year old students, while the 9 and 13 year old cohorts improved somewhat. Western youth at all three age levels scored near the national norm. Those in the Northeast were above and those in the Southeast were below that norm. Rural youth were also found to have improved their scores (National Assessment of Educational Progress, 1978).

In 1979, NAEP reported that blacks, poor whites, Hispanics and females tended to perform below the national norms at all three age levels tested. It was also reported that leaders in all sectors of American enterprise are being selected from the ranks possessing scientific and technical competence. Consequently, those youth with poor science awareness even if not aspiring to leadership positions, are likely to be handicapped when seeking positions in post industrial society's service organizations that are technology intensive (National Assessment of Educational Progress, 1979a).

In a related study, NAEP data show that teenage males are more likely than females to hold favorable attitudes toward science classes and careers, to have had science related experiences, and to use the scientific method of inquiry. Also, teachers reported insufficient knowledge and a lack of in-service training as major barriers to their effectiveness in teaching science information (National Assessment of Educational Progress, 1979b).

The diverse problems related to science understanding concerning both teachers and their students continue into the decade of the 1980's. NAEP reported in 1983 that even academically able students lost ground in mathematics and science abilities which were regarded as critical to this technological society. For students at ages 9, 12, and 17, scores fell 2.5 to 4.3 percentage points over a seven year period (National Assessment of Educational Progress, 1983).

These data document the declining science awareness of American youth over a decade. No better data exist to document the problem. Moreover, the need for all students to master science information in this society is well documented. Since vocational students interface directly with all aspects of this technology-based society, their science knowledge is not related to consumer utilization only, but to occupational prowess as well.

Such facts and observations support this project's goal which was to identify content to create an instrument which can be used to assess utilitarian science

information in relation to vocational specialization. In subsequent assessments, the information produced can be used for curriculum development, further research, and remediation of science skill deficiencies in selected vocational students.

Methods

The objective of this project was to identify the substantive content for a Science Skill/Knowledge Inventory which can be used to determine which basic science knowledges (skills, concepts) are judged to be essential for optimum success in secondary vocational specialties and the need for remediation of such skills in entering vocational students.

In identifying the content for the Science Skill/Knowledge Inventory, the researcher utilized various procedures. For example, (1) science literature was analyzed, (2) the topical content of secondary science textbooks was documented, and (3) the research in science education was studied. These sources of information were accessed through the collections of four college and university libraries, curriculum materials and media centers, and secondary school science texts.

Science topics were generated from the sources cited. They were then entered into the computer, alphabetized, sorted and evaluated for duplication, clarity, and reasonability for the purposes of the project.

In these tasks it was realized that this project could address only the science topics needed in non-health related vocational specialties. It became clear that a science skill inventory which would adequately measure skills or awarenesses needed in health related specialties would require the listing of nearly all biological terms. For example, the terms parasite, alimentary, crepitation, Dilantin, boric acid, mitosis, antibody, musculo-skeletal, arhythmia, among hundreds of others would apply directly to health careers but probably not to other vocational specialties. An instrument which would list them all would be interminably long and irrelevant for most vocational populations.

Analysis

Given the above facts, the science topics generated from the survey process were screened and evaluated in terms of their perceived utility in vocational specialties.

The following list of 334 science skills (topics, concepts) are the product of the research, the content items for the Science Skill/Knowledge Inventory.

Absorption
Absolute Temperature
Absolute Zero
Acceleration
Acid Base Indicators
Acidity - Alkalinity
Action - Reaction Principles
Adaptation
Adhesion
Adsorption
Aerodynamic Lift
Alloys
Alpha Particles
Alternative Current
Amalgams
Amino Acids
Ampere
Amplification
Anolog Digital Conversion
Anemometer
Animal Phyla
Annealing
Archimedes Principle
Atmospheric Pressure
Atomic Mass
Atomic Symbols
Atomic Weight
Bacteria
Barometric Principles
Basic Circuits
Binary Compounds
Boiling - Freezing Points
British Thermal Units
Buffer Solutions
Buoyancy
Calorie
Capacitance
Capacitors
Capillarity
Case Hardening
Catalysts
Cell Structures
Cells and Batteries
Cell Reproduction
Cellular Differences
Celsius Scale - Centigrade
Center of Gravity
Central Nervous System
Centrifugal Force
Centripetal Force
Centrifugation
Changes of Matter
Charges - Attractive
Charges - Repelling
Characteristics of Metals
Chemical Elements
Chemical Metals
Chemical Reactions
Chemical Symbols
Chemical Bonding
Chemical Equilibrium
Chemical Precipitation
Chemistry of Flame
Chemical Compounds
Chemical Equations
Chemical Notation
Chemical Changes
Chlorophyll
Chromosome Theory
Circulation
Coagulation
Cohesion

Colloids - Gas, Liquid
Color Complimentarity
Combustion Theory
Combustion - Oxidation
Compressibility
Compounds
Compression
Compounds and Mixtures
Concave Surfaces
Conduction Electrical
Conduction Thermal
Conductance
Conductors
Conductivity - Solids, Liquids
Conservation of Energy
Conservation of Mass
Convex Surfaces
Convection
Convection of Heat, Cold
Crystallization
Decomposition, Radioactive
Decomposition, Biological
Dehydration
Density
Density Calculations
Dew Point
Diffusion in Liquids
Diffusion of Gases
Digestion
Diodes
Direct Current
Displacement Reactions
Distillation
DNA
Dominance
Doppler Effect
Dormancy
Ductility
Ecological Principles
Efficiency - Mechanical, Electrical
Elasticity
Electromagnetism
Electron Theory
Electric Fields
Electrolysis
Electron Sharing
Electrolytes
Electrodes
Electrical Energy
Electromotive Forces
Electrovalence
Electro Waves
Electron Movement
Electrical Charges
Electronic Principles
Electron Emission
Electron Theory
Electrons, Neutrons, Protons, Ions
Electroplating
Elements
Emulsions
Energy Potential
Energy Kinetic
Energy - Mechanical, Electrical, Chemical
Evaporation
Expansion/Contraction
Fahrenheit Scale
Fermentation
Filtration
Fission
Focal Planes
Focal Points

Food Chains
Force Laws
Force, Work, Power, Energy
Fractional Distillation
Fractional Crystallization
Fractionation of Fluids
Freezing Points
Freezing Principles
Free Fall Principles
Frictional Forces
Fulcrum
Gas Laws
Gas Calculations
Germ Theory of Disease
Germination
Gravitational Forces
Half Life
Halogens
Hormones
Horsepower
Hydrolysis
Hydraulics
Illumination
Image - Object Relations
Immunity
Inertia
Inert Gases
Insulation Thermal
Insulators
Insulation, Electrical
Ionization
Isotopes
Kindling Temperature
Laser Beams
Laws of Motion
Laws of Refraction
Laws of Reflection
Lens Principles
Levers
Light Principles
Liquification of Gases
Litmus Paper
Luminosity
Magnetism
Magnification
Magnetic Theories
Mechanical Energy
Mechanical Advantage
Membranes
Metal Bonding
Metabolism
Metamorphosis
Metric Systems
Microorganisms
Microwaves
Minerals
Mirrors and Images
Miscibility
Mixtures
Molecular Weight
Molecular Attraction
Molecular Structure
Moment of Force
Momentum
Motion
Mutation
Nature of Solutions
Non-Metals
Nuclear Energy
Nuclear Fission
Nuclear Fusion
Optics

Oscillation
Osmotic Pressure
Osmosis
Oxidizing Agents
Oxidation - Combustion
Parasites
Parallel Circuits
Pasteurization
Periodic Table
Permeability of Membranes
Permeability
Ph Measures
Photosynthesis
Photo Electric Cells
Physical Changes
Physical - Chemical Properties
Pitch
Plant Phyla
Plasticity
Polarity
Polarization
Positive and Negative Charges
Pressure
Pressure Calculations
Primary Colors
Prisms
Properties of Liquids
Properties of Gases
Properties of Solids
Properities of Solutions
Properties of Air
Properties of Chemical Metals
Properties of Crystals
Properties of Matter
Protoplasm
Protozoa
Proteins
Pulleys and Inclined Planes
Pulse Waves
Radiation
Radio Waves
Radiation Principles
Radiation of Heat, Cold
Reflection
Reflexes
Refrigeration
Refraction
Refraction of Prisms
Resistance Electrical
Resistance Frictional
Respiration
Resultant Forces
Reversible Reactions
Rheostatic Principles
Right Hand Rule
Scientific Method
Secondary Colors
Sedimentation
Selection
Sensory System
Series Circuits
Shearing Forces
Simple Machines
Siphons
Solubility
Solvents
Sound
Specific Head
Spectrum
Specific Gravity
Speed of Light
Spontaneous Combustion

Static Electricity
States of Matter
Sublimation
Surface Tension
Suspensions
Taxonomies
Temperature Conversions
Tempering
Tensile Strength
Tension
Tests for Acids, Bases
Thermocouples
Tissue Structures
Titration
Torque
Torsional Forces
Toxins
Transformers
Transpiration
Transformations of Energy
Transistors
Transparency
Transmutation
Types of Tissue
Unicellular Organisms
Vacuums
Valence
Valence Bonds
Vaporization
Vapor Pressure
Vapors and Gases
Velocity, Acceleration
Vibration
Viscosity
Volatility
Voltage
Voltaic Cells
Volt, Ohm, Ampere, Watt
Volume
Volumetric Changes
Volume Measurement
Water Pressure Principles
Wavelength
Weight and Mass Measurements
Weight Volume Relationships
Wheatstone Bridge

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National NAEP. Wally Schirra: Science is low on the totem pole. NAEP-NL VIII, (2), 3-4, March-April 1975.

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NAEP. Attitudes toward science are mixed. NAEP-NL XII, (6), 2, December 1979b.

NAEP. Low achievers improve reading skills but top students lose ground in math, science. NAEP-NL, (1), 1-2, Winter 1983.